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TREATMENT OF SCREENINGS TO IMPROVE THE NUTRITIONAL VALUE FOR CATTLE AND DESTROY WEED SEED VIABILITY

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by

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for

The Weyburn Inland Terminal Ltd.

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SUMMARY

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Weyburn Inland Terminal Ltd. cleans grain before it is shipped to the lakehead, saving the expense of shipping the screenings east, pelletizing, and shipping the pellets back west. In doing so they do incur a cleaning cost which must be recovered. They produce about 3500 tonnes of refuse screenings each year. The majority of these screenings are sold to feed mills in Alberta where they are resold as ingredients of cattle rations and range pellets. The local market is small because of the viable weed seed content of the screenings. The company would like to significantly increase this market by destroying the weed seed viability and eliminate the cost of shipping the screenings to Alberta.

The objective of this project was to determine the effect of ammonia treatment on the viability of the weed seeds contained in the screenings, on the nutritive value of the screenings, and on the intake and digestibility of the screenings by sheep and steers.

The viability of all weed seeds was virtually destroyed after one day exposure to 3% ammonia at 20% moisture. One percent ammonia was not nearly

as effective. At or above freezing there appeared to be substantial decreases in viability after 3 days exposure, but 15 days were required at lower temperatures. Although 3% ammonia completely destroys weed seed viability very rapidly, its use would necessitate a recovery system to trap and reuse the excess ammonia. This would greatly complicate and increase the cost of the operation, especially during the winter when temperatures were below the freezing point.

Therefore, in order to design a practical process, it will be necessary to establish the maximum acceptable weed seed count in refuse screenings, and the longest acceptable time the screenings can be left exposed to ammonia before shipment. Then it will be necessary to establish the minimum amount of ammonia and the lowest moisture content which will meet these criteria..

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ABSTRACT

Weyburn Inland Terminal Ltd. would like to implement a cost effective process to reduce weed seed viability in their refuse screenings. Steam pelletizing will destroy weed seed viability but is an expensive process with a high initial capital cost. Under certain conditions ammonia treatment will also destroy weed seed viability and at the same time increase the nutritive value of the screenings for ruminant animals. More information about specific ammoniation conditions is required before a process for the continuous ammoniation of screenings can be designed.

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BACKGROUND AND OBJECTIVES

Most of the grain that is produced in Saskatchewan is shipped directly from the elevators to the Lakehead where it is cleaned before it is exported. The residue from cleaning, termed "screenings", offers a potentially valuable source of protein and energy to the livestock feeding industry. Much of the screenings at the Lakehead are pelletized and then shipped back to the west for use in cattle rations. This is expensive and alternatives are being investigated.

One alternative being used by the Weyburn Inland Terminal, is to clean the grain and then sell the screenings as a feed source without incurring the high costs of pelletizing and shipping the screenings both east and west. This decreases the dockage cost to the farmer, but incurs a cleaning expense which must be offset by the sale of the screenings. The screenings are separated into three categories. The first consists mainly of shrivelled and broken kernels of grain, and the second is mostly wild oats. The third category is called "refuse" screenings and consists of chaff and weed seeds other than wild oats. It is this fraction we are concerned with in this project.

Weyburn Inland Terminal produces up to 3500 tonnes of refuse screenings per year. Some are sold locally but about 80% is sold to feed mills in southern Alberta which use them as ingredients in cattle rations and supplemented feeds. The Terminal would prefer to sell locally and save the $15-$20 per tonne freight cost. The major obstacle against increasing the local market is the viability of weed seeds which normally make up about 30% of the refuse screenings.

It has been determined that, under certain conditions, ammonia treatment will destroy weed seed viability (Kernan, unpublished). Ammonia treatment can also increase the nutritive value of non-rolled barley grain (Rode et al. 1986; Matheson et al. 1989) and of chaff (Kernan et al. 1989). If refuse screenings can be improved to give a high quality product which would be accepted by the livestock industry, it would provide a potentially valuable feed source. If all screenings had a good market and could be separated locally, it should reduce the dockage loss on shipping which is presently charged to the producers.

A serious problem with feeding rations high in screenings is that general recommendations on their use are almost impossible to develop due to the extreme variability between samples of screenings both in botanical, and also in chemical composition. Another problem which can occur in the feeding of screenings is that many of the weed seeds can pass through the animal in an intact form. These seeds may not have been altered in the digestive tract and may still be viable, leading to weed problems when the manure is spread on the land. Traditionally this problem can be reduced by pelletizing the screenings. Recent work by Kernan (unpublished) shows that ammoniation may also reduce or eliminate the viability of the weed seeds. Ammoniation, besides decreasing weed seed viability, may increase the nutritive value when treated under the proper conditions.

The object of this project was twofold. Firstly, the work was done to examine the comparative nutritive values of screenings that were steam pelletized, left untreated, had undergone chemical treatment with ammonia, or

were supplemented with urea. This nutritive value was determined both in the lab with in vitro organic matter digestibility (IVOMD) or by in vivo feeding trials with cattle and sheep. The second objective was to compare the viability of weed seeds that had passed through the animals' digestive tract in untreated and pelletized screenings, and observe the effects of chemical treatment with ammonia or urea on weed seed viability.

EXPERIMENTAL METHODS

Saskatchewan Research Council at Saskatoon, SK.

1. Laboratory Studies

(a) Weed Seed Count

All samples were analyzed for weed seed type and content.

(b) Germination Tests

Germination tests were conducted by placing 20 seeds on a filter paper in a Petri dish with 4 ml of distilled water. The seeds were left to germinate in the dark, in an incubator at 20°C, and counted after 120 hours unless specified otherwise. This test was conducted on all screenings samples without separating weed varieties and in some cases on separated weed varieties. These tests were conducted on ammonia treated and untreated (control) seeds. Control seeds were reconstituted to the same moisture content as the treated seeds, and were maintained at the same temperature for the same length of time.

(c) Ammonia Treatment (All samples were air dried at room temperature prior to germination and analysis)

(1) 3% Ammonia, 20% moisture, 20°C for 1, 3, 6, 15, and 21 days.

(2) 3% Ammonia, 20% moisture for 21 days at 20°C, 0°C, -10°C.

(3) 1% Ammonia, 20% moisture, 20°C for 1, 3, 6, 15, and 21 days.

(4) 3% Ammonia, 20% moisture, 0°C for 1, 3, 6, 15, and 21 days.

(5) 1% Ammonia, 20% moisture, 0°C for 1, 3, 6, 15, and 21 days.

(6) 3% Ammonia, 20% moisture, -10°C for 1, 3, 6, 15, and 21 days.

(7) 1% Ammonia, 20% moisture, -10°C for 1, 3, 6, 15, and 21 days.

(d) A literature search was conducted to obtain information on toxic compounds contained in weed seeds, especially those seeds found in relative abundance in these screening samples.

(e) Samples of untreated screenings were analyzed for saponin, alkaloid, nitrate, and oxalate at the Saskatchewan Research Council. The saponin analysis used an hemolytic method developed by Reichert et al. (1986). A GLC analysis (Smith 1989) did not detect the alkaloid and alkaloid like compounds (acetyltryptamine and p-phenoxyphenethylamine) found in Kochia scoparia. More general alkaloid analyses should be developed for testing screenings in phase II of this project. Both untreated and ammoniated screenings were analyzed for crude protein (CP) at the Feed Test Laboratory, University of Saskatchewan, and for IVOMD using the procedure of Tilley and Terry (1963), as modified by Troelson (1971).

(f) Pelletizing Study

A limited study of the effect of steam pelletizing untreated screenings and those treated with ammonia and urea was conducted, based on the work of Bergner (1972, 1972a, 1973, 1977) in Germany.

2. Feeding Trials

About one third of the screenings shipped to Swift Current from Weyburn were reconstituted to 15% moisture in a mix mill and treated with 3% ammonia at an ambient temperature of about -10°C. The ammonia was added to the screenings through a cold-flo adapter, placed about half way up an auger, while

the screenings were being transferred to an epoxy lined grain bin. The screenings were left in the bin for about one month before any pelletizing or feeding trials were started

The project itself involved several different phases. The first phase involved 142 hereford steers. One pen of 72 steers began the trial February 24, 1989 with an average weight of 260 kg (573 lb). These steers were then fed an average of 2.5 kg (5.6 lb) of untreated screenings daily while consuming hay free choice. They consumed on average, 5.3 kg (11.7 lb) of hay daily. The second pen of 70 steers also started the trial on February 24 and weighed 263 kg (579 lb) on average, and also consumed 2.5 kg (5.6 lb) of ammoniated screenings and 5.3 kg (11.7 lb) free choice hay daily. Both the untreated and the ammoniated screenings were fed in a loose form.

The second phase of the project involved feeding trials in which 24 steers and 32 sheep were put into metabolism stalls and four animals were each fed one of eight diets, allowing determination of the nutritive value of these diets. The diets that were fed are as follows:

diet 1	Pelletized screenings and hay.
diet 2	Screenings and hay.
diet 3	Pelletized ammoniated screenings and hay.
diet 4	Ammoniated screenings and hay.
diet 5	Pelletized urea treated screenings and hay.
diet 6	Urea treated screenings and hay.
diet 7	Pelletized hay
diet 8	Hay.

Diets 1 through 6 were then fed to both steers and sheep over several months with three different feeding periods. Period 1 involved feeding 60%

screenings and 40% chopped, brome-alfalfa hay. Periods 2 and 3 again included the same dietary constituents only changing the level of screenings in the diet from 60% to 40% in period 2 and to 20% in period 3 while the proportion of hay increased to 60% and 80% in periods 2 and 3 respectively. Diets 3 and 4 were treated with 3% ammonia, while the 1% urea was added to the screenings in diet 5 and 6. Diets 7 and 8 (hay) were fed at the same time as diets 1 to 6 in the sheep trial and following completion of the feeding of diet 1 to 6 in the steer trial. These hay diets were fed as a control and also to allow comparisons to be made among screenings diets since this was the same hay as fed in the screenings containing diets. During the time that the feeding trials were taking place, samples of the screenings were collected to determine the botanical composition of the screenings component of the diet.

The third phase of the project involved laboratory analysis of the feeds and feces for organic matter (OM), CP, cellulose, energy, neutral detergent fiber (NDF), acid detergent fiber (ADF), and phosphorous (P) as well as IVOMD. Digestibilities and intakes of components of the rations were calculated from animal data and composition of feeds and feces.

The last aspect of this project was to conduct germination studies on the feces to investigate the viability of the seed following passage through the ruminant digestive tract. Twenty g samples of manure, collected from both sheep and steers was planted in soil to determine the weed seed viability. Samples were planted fresh and frozen at -30°C to determine if the freezing had any effect on germination. This work included observation of the effects of the steam pelletizing and chemical treatments on the viability of the seeds.

RESULTS AND DISCUSSION

1. Preliminary Study

A preliminary study was conducted by the Saskatchewan Research Council (SRC) on a sample of refuse screenings from the 1987 harvest, separated at the Weyburn Inland Terminal. Four samples were examined for weed seed content (Table 1).

Table 1. Weed Seed Distribution in 1987 Screenings Sample.

Weed	No. of seeds/100mg	% Seeds by wt.
Green Foxtail	13.9	35.8
Lamb's-quarters and Redroot Pigweed	85.2	52.8
Chaff	---	12.2
SE of mean	3.58	1.94

Sub-samples of these 1987 screenings were reconstituted to specific moisture contents and treated with ammonia (Table 2). The results indicate that ammonia treatment at concentrations as low as 1%, does significantly reduce weed seed viability, but a moisture content of 15% or greater is required for this effect.

Table 2. Effect of Ammonia Treatment on the Viability of Weed Seeds from Screenings.

% NH_3	$\%H_20$	% Germination (72 hr)
Control	6.7	44
1	6.7	39
1	10	15
1	15	0
1	20	5
3	20	0
SE of mean	—	3.21

Exposure Time - 21 days: Temperature - +20°C.

For the past two years, screenings have been produced which contained a much higher percentage of weed seeds than usual. In this case, the nutritive value of the screenings would be quite high if the weed seeds could be utilized by the animal. Unfortunately, many whole weed seeds pass through the animal into the manure. When this manure is spread on the land as fertilizer, there is the possibility that viable weed seeds would be spread along with it.

The in vitro nutritive value of screenings was also increased by ammonia treatment (Table 3) under the recommended crop residue treatment conditions of 3% ammonia, 20% moisture and 20°C (Kernan and Knipfel 1990).

Table 3. Effect of Ammoniation on the Nutritive Value of Screenings.

Treatment	%CP	%IVOMD
Untreated	17.2	58.4
Ammoniated	21.3	65.3
SE of NH_3 Effect	<0.001	<0.001

NH_3 - 3%: H_2O - 20%: Temperature - +20°C.
CP - Crude Protein
IVOMD - In vitro organic matter digestibility

Indications are that, under the proper conditions, ammonia treatment will destroy weed seed viability and also enhance the IVOMD. It remains to be determined if ammonia treatment will increase the utilization of whole weed seeds by cattle.

2. Laboratory Study

A large quantity of screenings was transported from Weyburn to Swift Current early in 1989. The screenings were processed at Swift Current and samples of processed and unprocessed screenings were sent to Saskatoon.

(a) Weed Seed Content

The sample of the screenings sent to Swift Current for the animal trials contained the following weed seed content:

68% Green Foxtail

10% Lamb's-quarters and Redroot Pigweed

8% miscellaneous weed seeds

24% chaff

Ammonia Treatment and Germination Tests

Sub-samples of this screenings sample were treated with 1% and 3% ammonia at 20°C, 0°C, and -10°C at 20% moisture for 1, 3, 6, 15, and 21 days. Germination tests were conducted on these seeds and control seeds. The viability of all weed seeds was virtually destroyed after one day exposure to 3% ammonia at 20% moisture (Table 4). One percent ammonia was not nearly as effective. At or above freezing there appeared to be reasonable decrease in viability after 3 days exposure, but 15 days were required at the lower temperature.

Table 4. Effect of Exposure to Ammonia on Weed Seed Viability

Ammoniation		% Germination Exposure Time (days)				
Temp.(°C)	Conc.(%)	1	3	6	15	21
20	0	--	--	--	--	55
20	1	18	8	13	15	6
20	3	0	0	0	0	0
0	0	--	--	--	--	60
0	1	29	9	8	8	1
0	3	0	1	0	0	0
-10	0	--	--	--	--	65
-10	1	45	26	29	0	4
-10	3	3	0	0	0	1

All tests conducted at 20% Moisture

Although 3% ammonia completely destroys weed seed viability very rapidly, its use would necessitate a recovery system to trap and reuse the excess

ammonia. This would greatly complicate and increase the cost of the operation when conducted on a commercial basis, and would be especially true during winter operation at temperatures below the freezing point.

Therefore, if the ammonia process is to be a practical method of reducing weed seed viability, more information is required. It becomes necessary to establish the maximum acceptable amount of viable weed seeds in refuse screenings, the maximum acceptable time the screenings can be left exposed to ammonia before shipment, and to establish the minimum amount of ammonia and the lowest moisture content which will meet these criteria. In order to obtain this information, it will be necessary to examine ammonia concentrations between 1% and 3% and moisture contents between 10% and 15%.

It is also necessary to determine how well unprocessed and ammoniated weed seeds are utilized by the ruminant animal. If ammoniated weed seeds are not reasonably well utilized, a rolling or pelletizing process may be required which might make the ammonia treatment redundant.

(b) Pelletizing Study

Six rations containing screenings were prepared at Swift Current for the performance, digestibility, and intake trials. They consisted of untreated, ammoniated, and urea treated screenings both loose and steam pelletized.

The loose rations were examined to determine their weed seed content (Table 5), and germination tests were conducted on the major weed fractions in each sample (Table 6). The content of the screenings differs somewhat from the previous samples, but the germination results are similar.

Table 5. Weed Seed Content of Loose Rations.

Weed	% by wt.		
	1. Untreated	2. Urea	3. Ammoniated
Redroot Pigweed	6.4	11.2	6.1
Lamb's-quarters	4.3	4.8	4.4
Green Foxtail	47.7	39.1	44.4
Miscellaneous	8.6	11.8	15.3
Chaff	33.0	33.1	29.9

Table 6. Effect of Processing on the Viability of Weed Seeds in Loose Rations.

Weed	% Germination		
	1. Untreated	2. Urea	3. Ammoniated
Redroot Pigweed	62	30	3
Lamb's-quarters	43	48	2
Green Foxtail	63	55	0
Miscellaneous	15	10	0

3% ammonia - 20% moisture - -10°C.

These results show that even under large scale conditions at freezing temperatures, 3% ammonia significantly reduces the viability of all the weed seeds found in these samples of screenings. It is also obvious that the samples of screenings differ considerably from each other in the relative proportions of common weed seeds they contain.

Germination tests were also done on the pelletized rations. Even though the screenings were not ground prior to steam pelletizing, and the pellets broke up very easily, very few whole seeds were observed in the residue from the

pellets. One gram of carefully broken up pellets from each treatment, were planted into soil. Since nothing grew, we concluded that steam pelletizing whole screenings completely destroys weed seed viability.

All six rations were ground and in vitro dry matter digestibility (IVDMD) analyses were determined on representative samples of each ration (Table 7).

Table 7. Effect of Processing on the Crude Protein Content and In Vitro Dry Matter Digestibility of Screenings.

Ration	%IVDMD	%CP
1. Untreated - Pellets	56.4	17.1
2. Untreated - Loose	57.5	18.2
3. Ammoniated - Pellets	59.2	23.6
4. Ammoniated - Loose	64.4	24.4
5. Urea - Pellets	56.7	24.5
6. Urea - Loose	63.8	24.7

IVDMD - In vitro dry matter digestibility

Three computer searches were conducted in an attempt to locate articles concerned with toxic components in weed seeds, with particular reference to Green Foxtail, Redroot Pigweed and Lamb's-quarters. Several references such as Day and Dilworth (1984) and Nelson et al (1982) were found which discussed toxic alkaloids in Jimson weed seed meal. This weed is common to the western corn belt of the USA and is found to contaminate grain screenings used in Mississippi, Alabama, and Louisiana. Jimson weed is not found in Western Canada. No references pertaining to toxic components in weed seeds common

to Saskatchewan, specifically Green Foxtail, Redroot Pigweed, and Lamb's-quarters were found.

Representative samples of all six rations used in the feeding trail were analyzed for oxalate, nitrate, saponin, and alkaloid. All six rations contained a small amount of soluble oxalate and two showed traces of nitrate (Table 8). Saponins and the specific alkaloids discussed in the experimental section were not detected in any of the rations.

Table 8. Toxic Components of Rations.

Ration	Oxalate (%)	Nitrat	Alkaloid	Saponin
1. Untreated Pellets	0.20	neg.	neg.	neg.
2. Untreated Loose	0.25	neg.	neg.	neg.
3. Ammoniated Pellets	0.36	neg.	neg.	neg.
4. Ammoniated Loose	0.43	trace	neg.	neg.
5. Urea Pellets	0.20	neg	neg.	neg.
6. Urea Loose	0.17	trace	neg.	neg.

Samples of manure collected from both the steer and sheep digestibility trials were tested for viable seeds by planting 20 g samples of manure in soil. Very few seeds were observed to germinate in manure from the pelletized and ammoniated rations. Although the general trend was the same, fewer seeds germinated from the sheep manure than from the steer manure (Table 9).

Table 9. Weed Seed Germinations from Steer and Sheep Manure.

Ration	Average number of Germinations			
	Redroot Pigweed	Lamb's-quarters	Green Foxtail	Misc.
Steer Manure				
1. Untreated Pellets	2.5	0.5	0.5	0
2. Untreated Loose	36.5	1.8	4.0	0.5
3. Ammoniated Pellets	0.3	0	0	0
4. Ammoniated Loose	1.0	0.3	0.3	0.3
5. Urea Pellets	0.3	0	0.3	0.3
6. Urea Loose	43.5	3.5	6.3	0.8
Sheep Manure				
1. Untreated Pellets	0	0	0	0
2. Untreated Loose	11.3	6.3	0.3	1.3
3. Ammoniated Pellets	0	0	0	0
4. Ammoniated Loose	0	0	0	0.3
5. Urea Pellets	1.0	0.8	0	0
6. Urea Loose	14.8	14.5	0.3	1.3

The results from steer manure indicate that only Redroot Pigweed seeds (and to a limited extent Lamb's-quarter seeds) retained their viability while passing through the animal. Green Foxtail, the weed seed present in by far the highest proportion, is either better digested, or its viability greatly reduced while passing through the steer.

(c) Feeding Trials

The gains observed for 142 steers from 24 February to 14 April 1990 were 0.29 kg/day (0.63 lb/day) for the plain screenings and hay ration, and 0.34

kg/day (0.75lb/day) for the ammoniated screenings and hay ration. Daily intakes of screenings were only 2.5 kg (5.6 lb).

A sample of the screenings was sent to the Western Seed Lab in Regina for analysis of botanical composition and percent germination of the four weeds present in the highest proportion (Table 10). Green foxtail makes up by far the greatest portion of the screenings. Several weed species which make up the "other seeds" portion of screenings are listed (Table 11).

Table 10. Botanical Composition of Screenings. Western Seed Lab Analysis Results .

Weed	% of mixture	% Germination
Green Foxtail	52.0	58
Lamb's-quarters	7.3	39
Pig weed	6.5	76
Other seeds	4.7	--
Kochia	2.2	14
Barnyard grass	1.8	--
Inert Material	25.5	--

Table 11. The Other Seeds Component in the Screenings

Stinkweed
Russian thistle
Wild buckwheat
Flixweed
Dock
Canary grass

Pelletizing resulted in an increase in IVOMD (Table 12) since it increases the exposed surface area of the seeds by cracking the seed coats. This allows greater access by rumen microorganisms, and thus more complete and faster digestion. Pelletizing appeared to reduce the cellulose, NDF, and ADF content of the feed. This may be due to the removal of volatile components from the fibre or among samples since the screenings are extremely variable. Ammonia treatment also increased IVOMD and reduced NDF and ADF of the screenings (Table 12).

Significant difference ($P<0.0001$) occurred among treatments in OM, CP, cellulose, energy, NDF, and ADF for each of the different time periods or levels of screenings for both sheep (Table 13) and steers (Table 14). Pelletized rations, for both sheep (Table 13) and steers (Table 14), were significantly higher ($P<0.0001$) in digestible organic matter (DOM) than non-pelletized rations that had undergone the same chemical treatment. The urea treated diets (diets 5 and 6) do not show a significant difference although the trend is the same. On the other hand, the DOM of chopped hay (diet 8) was significantly higher than that of the pelletized hay diets (diet 7) for both sheep (Table 13) and steers (Table 14). The in vitro values (Table 12) do not confirm this trend as the pelletized hay had the higher IVOMD. A possible explanation for this is that the high intake of pelletized hay resulted in a high rate of passage and a lower in vivo digestibility. As the level of screenings in the diet decreased, significant increases in digestibility were observed (illustrated by an asterisk in Tables 13 and 14).

Table 12 Composition and *in vitro* digestibility of the Rations

Dietary Component	DM	OM (%)	Cell	GE kcal/g	ADF	NDF	CP (%)	P	IVOMD
UNTREATED									
Pelleted	89.8	81.8	13.1	4.6	18.6	32.2	17.2	0.45	46.1
Loose	89.2	84.1	16.9	4.0	29.8	46.7	14.2	0.39	42.3
AMMONIATED									
Pelleted	87.4	86.6	12.6	4.1	20.0	29.8	23.8	0.48	59.0
Loose	86.9	89.7	17.2	4.3	26.0	42.1	20.6	0.41	55.9
UREA TREATED									
Pelleted	87.3	83.6	13.6	4.0	21.8	33.5	20.1	0.43	48.1
Loose	89.1	85.6	15.1	4.2	27.2	46.4	23.8	0.42	44.1
HAY									
Pelleted	89.9	91.3	24.8	4.4	27.4	41.1	18.9	0.23	66.2
Loose	89.0	90.6	28.9	4.3	30.7	49.1	15.8	0.25	61.3

DM - Dry matter
OM - Organic matter
Cell - Cellulose
GE - Gross energy
ADF - Acid detergent fibre
NDF - Neutral detergent fibre
CP - Crude protein
P - Phosphorus
IVOMD - *In vitro* organic matter digestibility.

Table 13. Sheep Digestibility of Ration Components.

Diet	Level of Screenings	DOM	DCP	DCELL	DENERGY	DNDF	DADF
		(%)					
UNTREATED							
1 Pelleted	60%	55.7*	59.4	38.6*	57.4	37.3*	29.6*
	40%	62.2	64.6	55.0	61.2	49.7	45.4
	20%	64.3	67.5	62.9	61.4	57.9	52.7
2 Loose	60%	46.5*	50.1*	36.6*	42.6*	41.4*	39.9*
	40%	54.7	54.4	54.3	50.3	51.4	50.7
	20%	60.8	64.3	61.6	56.1	56.8	55.1
AMMONIATED							
3 Pelleted	60%	58.7*	61.9	43.5*	56.1	42.0*	37.8*
	40%	64.6	67.4	59.2	61.1	52.9	52.9
	20%	63.6	67.0	63.4	59.3	56.9	54.8
4 Loose	60%	50.2*	49.5*	43.9*	45.9*	42.6 *	40.7*
	40%	57.3	59.0	56.6	52.7	50.6	52.4
	20%	59.7	62.0	62.0	65.4	56.2	54.8
UREA TREATED							
5 Pelleted	60%	58.5	62.5	45.4*	55.9	42.9*	38.8*
	40%	61.1	64.0	56.2	57.9	48.0	49.9
	20%	62.3	65.5	61.7	58.1	56.3	54.2
6 Loose	60%	46.1*	60.2*	31.6*	42.7*	40.4*	31.9*
	40%	56.5	65.3	52.7	52.9	51.5	50.3
	20%	61.2	67.4	62.8	56.7	57.5	55.5
HAY							
7 Pelleted	0	42.8*	56.8*	26.4*	37.3*	16.3*	11.1*
	0	56.3	70.3	45.7	52.2	36.4	29.9
	0	54.2	67.1	48.5	49.5	38.9	36.6
8 Loose	0	59.2*	70.6*	58.3*	54.8*	50.3*	48.1*
	0	62.1	68.4	63.0	57.9	56.7	54.6
	0	67.3	71.9	69.7	63.2	63.8	61.6

* Indicates a significant difference ($p<0.05$) between digestibilities for each diet as the screenings level changed.

Table 14. Steer Digestibility of Ration Components.

Diet	Level of Screenings	DOM	DCP	DCELL	DENERGY	DNDF	DADF
		(%)					
UNTREATED							
1 Pelleted	60%	63.1*	62.9*	60.3*	62.4	54.5 *	50.4*
	40%	63.2	66.2	61.2	62.1	54.6	51.9
	20%	69.6	71.2	70.9	67.6	64.9	64.3
2 Loose	60%	53.2*	51.6*	53.6*	48.9*	50.8 *	49.9*
	40%	57.2	62.2	57.8	53.0	53.6	52.8
	20%	64.4	66.2	67.8	60.7	63.1	62.7
AMMONIATED							
3 Pelleted	60%	60.1*	61.4*	54.8*	56.4*	49.3 *	47.1*
	40%	61.2	63.3	58.2	57.8	53.0	51.6
	20%	66.8	67.0	68.8	63.4	65.7	62.5
4 Loose	60%	53.6*	53.9*	54.4*	49.1*	49.8 *	47.9*
	40%	57.4	59.5	59.2	53.1	54.7	52.6
	20%	60.5	62.0	63.4	56.1	57.1	57.3
UREA TREATED							
5 Pelleted	60%	54.1	55.6*	51.3	50.6	40.5 *	41.0*
	40%	59.7	64.6	55.8	56.4	46.8	49.3
	20%	62.2	64.6	63.3	58.5	57.8	57.0
6 Loose	60%	53.1*	62.5*	57.8*	48.7*	54.5	51.3*
	40%	57.8	69.6	56.9	54.1	54.3	51.6
	20%	64.2	69.2	67.0	60.8	61.6	61.8
HAY							
7 Pell	0	58.1	70.3	56.0	52.9	40.9	40.8
8 Loose	0	65.4	67.8	71.1	60.5	63.7	63.2

* Indicates a significant difference ($p<0.05$) between digestibilities for each diet as the screenings level changed.

Final Report

2.2-23

Treatment of Screenings to Improve The Nutritional Value for Cattle and Destroy Weed Seed Viability

Funded by

The Agriculture Development Fund

An increase in the digestible components of the rations occurred for both sheep (Table 15) and steers (Table 16) as the hay portion of the diet increased from 40% to 80%. One exception was the digestible crude protein (DCP) content which decreased as the level of screenings in the diet decreased when the CP levels in the screenings were higher than those in the hay. There was no significant change in DCP as the hay proportion increased for diets 1 and 2 where the screenings have a CP content similar to hay,. The digestible energy (DE) content in the diets showed only slight increase as the level of screenings decreased (Tables 15 and 16).

The intake of digestible nutrients was not significantly affected by the screenings content for either sheep (Table 17) or steers (Table 18).

Little germination was observed from either frozen or fresh manure from the pelletized and ammoniated rations (Table 19). Significantly higher germinations were observed for diets 2 and 6 which had not undergone either physical or chemical processing. Significantly more ($P<0.0001$) seeds germinated from fresh sheep manure than from frozen sheep manure, indicating that the freezing reduced the weed seed viability. No significant effect of freezing was observed in the germination results from steer manure (Table 19). A large number of grass seeds germinated, mostly from the Poa species. These must have come through the digestive tract whole and likely originated from the hay portion of the diet.

Table 15. Digestible Nutrients of the Sheep Diets.

Diet	Level of Screenings	DOM	DCP	DCell	DEnergy	DNDF	DADF
		(%)					
UNTREATED							
1 Pelleted	60%	44.3	10.2	7.0	2.6	13.9	6.6
	40%	51.3	10.7	11.6	2.7	20.1	11.3
	20%	54.6	10.9	15.3	2.6	26.3	14.4
2 Loose	60%	37.7	7.6	7.5	1.8	19.4	11.6
	40%	46.0	8.3	12.6	2.1	24.5	15.2
	20%	52.2	10.0	16.1	2.4	27.6	16.8
AMMONIATED							
3 Pelleted	60%	47.7	13.2	7.8	2.4	15.2	8.9
	40%	54.8	13.1	12.7	2.6	21.4	13.7
	20%	54.8	11.7	16.0	2.5	25.7	15.6
4 Loose	60%	41.1	9.6	8.9	2.0	18.5	11.0
	40%	48.9	10.6	13.3	2.3	23.2	15.0
	20%	51.8	10.4	16.3	2.4	26.8	16.3
UREA TREATED							
5 Pelleted	60%	46.5	11.8	8.4	2.3	16.4	9.5
	40%	50.7	11.3	12.3	2.4	18.5	13.3
	20%	53.1	10.9	15.8	2.4	25.9	15.6
6 Loose	60%	36.8	12.7	6.3	1.8	18.8	8.9
	40%	47.7	12.7	11.7	2.3	24.4	14.4
	20%	52.6	11.8	16.3	3.4	27.9	16.6
HAY							
7 Pelleted	0	34.5	10.9	6.4	1.6	6.7	3.1
	0	48.9	13.4	11.2	2.3	15.0	8.2
	0	46.8	12.7	12.0	2.2	16.0	10.1
8 Loose	0	50.8	11.7	16.3	2.3	23.8	14.1
	0	53.4	11.0	17.7	2.5	27.4	16.4
	0	59.0	11.4	19.9	2.7	31.2	18.8

Table 16. Digestible Nutrtients of Steer Diets.

Diet	Level of Screenings	Nutrient Content Percent (Mean of 4 animals)					
		DOM	DCP	DCELL	DENERGY	DNDF	DADF
		(%)					
UNTREATED							
1 Pelleted	60%	53.5	10.5	11.5	2.8	21.1	11.7
	40%	53.6	10.8	13.7	2.7	23.1	13.4
	20%	59.7	11.5	18.1	2.9	29.6	18.2
2 Loose	60%	43.7	7.6	11.7	2.0	24.4	15.2
	40%	48.8	9.4	13.9	2.2	25.9	16.2
	20%	55.5	10.3	17.9	2.6	30.8	19.3
AMMONIATED							
3 Pelleted	60%	49.8	12.6	10.4	2.4	18.5	11.5
	40%	53.0	12.0	12.9	2.4	22.0	13.7
	20%	57.7	11.6	17.5	2.7	28.9	17.9
4 Loose	60%	45.2	10.0	11.9	2.1	22.4	13.4
	40%	49.8	10.5	14.2	2.3	25.4	15.2
	20%	51.7	10.3	16.7	2.4	27.3	17.1
UREA TREATED							
5 Pelleted	60%	44.0	10.1	10.1	2.1	16.2	10.5
	40%	50.4	11.3	12.6	2.4	18.6	13.4
	20%	52.5	10.7	16.3	2.5	26.7	16.6
6 Loose	60%	44.5	12.5	12.2	2.1	26.3	15.0
	40%	49.6	13.6	13.4	2.3	26.4	15.3
	20%	55.2	12.0	17.5	2.5	30.1	18.7
HAY							
7 Pelleted	0	51.1	13.3	13.8	2.3	16.7	11.2
8 Loose	0	56.9	10.7	20.3	2.6	31.1	19.4

Table 17. Intake of Digestible Nutrients by Sheep.

Diet	Level of Screening	Consumption (Dig)/kg$^{0.75}$ Body Wt.					
		OM (g)	CP (g)	Cell (g)	Energy (kcals)	NDF (g)	ADF (g)
UNTREATED							
1 Pelleted	60%	56.8	12.3	8.2	306.8	16.5	7.8
	40%	52.4	10.5	11.3	259.4	19.6	11.0
	20%	45.7	8.8	12.2	211.9	21.3	11.7
2 Loose	60%	53.3	10.1	10.0	232.9	25.7	15.3
	40%	58.5	10.1	15.4	255.7	29.9	18.5
	20%	54.8	10.1	16.3	239.0	28.0	17.0
AMMONIATED							
3 Pelleted	60%	58.9	15.0	8.7	267.6	17.0	10.0
	40%	58.5	13.3	12.9	261.6	21.8	14.0
	20%	51.8	10.6	14.5	227.2	23.2	14.1
4 Loose	60%	55.1	11.7	10.8	238.6	22.6	13.4
	40%	58.3	12.0	15.0	253.9	26.3	16.9
	20%	49.8	9.6	15.0	216.7	24.6	15.0
UREA TREATED							
5 Pelleted	60%	60.4	14.3	10.0	274.4	17.5	11.3
	40%	58.0	12.3	13.3	260.5	20.0	14.5
	20%	53.1	10.4	15.1	233.3	24.8	15.0
6 Loose	60%	49.9	15.8	7.5	224.5	23.3	11.0
	40%	55.7	14.2	13.0	250.0	27.2	16.1
	20%	50.7	10.9	15.0	222.2	25.8	15.4
HAY							
7 Pelleted	0	52.2	14.5	8.5	216.8	9.0	4.1
	0	64.8	16.9	14.1	287.4	19.0	10.4
	0	63.0	16.1	15.2	274.6	20.4	12.9
8 Loose	0	45.2	9.9	13.7	196.4	20.1	11.9
	0	53.5	10.5	16.8	235.0	26.2	15.6
	0	53.6	10.0	17.5	235.7	27.5	16.6

Table 18. Intake of Digestible Nutrients by Steers.

Diet	Level of Screenings	Consumption (Dig)/kg$^{0.75}$ Body Wt.					
		OM (g)	CP (g)	CELL (g)	ENERGY (kcals)	NDF (g)	ADF (g)
UNTREATED							
1 Pelleted	60%	64.7	12.6	13.8	333.0	25.5	14.1
	40%	76.1	15.0	18.8	375.5	32.0	18.6
	20%	78.1	14.5	22.8	367.7	37.5	23.0
2 Loose	60%	63.0	10.4	15.9	275.9	33.3	2.5
	40%	69.9	13.1	19.4	307.6	36.1	22.5
	20%	76.0	13.5	23.5	337.3	40.7	25.4
AMMONIATED							
3 Pelleted	60%	69.0	16.4	13.6	306.9	24.2	15.0
	40%	73.8	16.3	17.5	328.9	29.8	18.5
	20%	77.5	15.1	22.6	346.8	37.3	23.2
4 Loose	60%	67.8	14.0	16.6	293.4	31.4	18.9
	40%	74.6	15.2	20.5	325.5	36.7	21.9
	20%	71.5	13.5	21.8	311.4	35.7	22.4
UREA TREATED							
5 Pelleted	60%	68.7	14.9	14.8	304.4	23.9	15.4
	40%	84.4	18.3	20.3	377.1	30.0	21.6
	20%	77.7	15.0	22.8	344.1	37.3	23.2
6 Loose	60%	47.9	12.9	12.5	211.9	27.0	15.4
	40%	71.9	19.1	18.8	322.8	37.1	21.4
	20%	77.3	16.1	23.5	345.9	40.4	25.0
HAY							
7 Pelleted	0	70.8	17.8	18.4	308.0	22.4	15.0
8 Loose	0	69.2	12.4	23.7	300.1	36.4	22.6

The results from these germination studies indicate that Redroot Pigweed seeds, and to a lesser extent Lamb's-quarters and Green Foxtail retained their viability while passing through the animal. The Green Foxtail seed, while present in by far the highest proportion, is either more susceptible to digestion, or it's viability was greatly reduced while passing through the animals. It appears that Redroot Pigweed and Green Foxtail were more adversely effected by the freezing than was the Lamb's-quarters.

Table 19. Average Weed Seed Germinations from Frozen Fecal Material of Steers. (20 gram sample of manure)

Ration	Average number of Germinations			
	Redroot Pigweed	Lamb's-quarters	Green Foxtail	Misc.
STEER MANURE				
Frozen Manure				
1. Untreated Pellets	4.0	0.5	0.4	0.0
2. Untreated Loose	82.3	11.3	4.1	1.3
3. Ammoniated Pellets	1.7	0.3	0.0	0.0
4. Ammoniated Loose	2.0	0.3	0.3	0.3
5. Urea Pellets	0.6	0.0	0.2	0.0
6. Urea Loose	71.9	13.5	3.9	1.2
Fresh Manure				
1. Untreated Pellets	13.0	2.8	3.8	3.8
2. Untreated Loose	61.8	13.3	25.8	7.0
3. Ammoniated Pellets	0.8	0.5	0.0	2.5
4. Ammoniated Loose	1.0	0.3	0.3	2.3
5. Urea Pellets	5.8	1.3	1.3	4.3
6. Urea Loose	43.8	10.5	21.8	1.3

These results are averages of three levels of feeding in the case of frozen manure, and one level for fresh steer manure.

Table 20. Average Weed Seed Germinations from Frozen Fecal Material of Sheep. (20 gram sample of manure)

Ration	Average number of germinations			
	Redroot Pigweed	Lamb's-quarters	Green Foxtail	Misc.
SHEEP MANURE				
Frozen manure				
1. Untreated Pellets	0.0	0.3	0.0	0.0
2. Untreated Loose	60.3	19.1	4.3	0.6
3. Ammoniated Pellets	0.1	0.0	0.0	0.0
4. Ammoniated Loose	2.0	0.3	0.7	0.2
5. Urea Pellets	0.4	0.3	0.0	0.0
6. Urea Loose	47.2	19.7	2.3	1.0
Fresh Manure				
1. Untreated Pellets	0.8	1.0	0.0	3.0
2. Untreated Loose	261.4	25.5	62.9	4.3
3. Ammoniated Pellets	0.8	0.6	0.8	3.9
4. Ammoniated Loose	0.5	1.0	0.0	5.7
5. Urea Pellets	1.6	0.6	0.1	5.3
6. Urea Loose	298.8	24.8	29.9	7.5

CONCLUSIONS, RECOMMENDATIONS, AND IMPACT

1. Laboratory Study

We have determined that steam pelletizing completely destroys weed seed viability. Weyburn Inland Terminal does not, however, plan to install pelletizing equipment at this time.

Ammonia treatment with 3% ammonia at 20% moisture virtually destroys weed seed viability at temperatures from -10°C to +20°C after 1 day exposure. One percent ammonia reduces weed seed viability to a very low percentage after 21 days exposure under the same conditions.

We must establish the highest acceptable weed seed germination percentage in ammoniated refuse screenings, and the longest acceptable ammonia exposure time. More laboratory studies are required to establish the lowest amount of ammonia and the lowest moisture content which would reduce weed seed viability to this germination rate within this time period.

2. Feeding Trials

The results of this study show that pelletizing, ammonia treatment, and the addition of urea, increase the digestibility of the screenings, and in all cases the increases are additive (Tables 12 and 21). However, these additive increases may not always be significant. The ammonia and urea treatments also increase the CP content of the diets.

Table 21. Effect of Processing on the Crude Protein Content and In Vitro Dry Matter Digestibility of Screenings.

Ration	%IVOMD	%CP
1. Untreated - pellets	46.1	17.2
2. Untreated - loose	42.3	14.2
3. Ammoniated - pellets	59.0	23.8
4. Ammoniated - loose	55.9	20.6
5. Urea - pellets	48.1	20.1
6. Urea - loose	44.1	23.8
7. Hay - pellets	66.2	18.9
8. Hay - loose	61.3	15.8

IVOMD - In Vitro organic matter digestibility

The trends in digestibilities of the dietary constituents are shown by the regression lines in figures 1 to 12 which follow. In these diets, the digestibilities of various constituents increase as the levels of screenings decrease.

The germination results showed that steam pelletization almost completely destroys weed seed viability. Ammoniation with 3% ammonia also decreased or eliminated most viable seeds. Killing the weed seeds is important as the manure is often spread on the fields as fertilizer. These results show that both ammoniation and pelletizing will effectively lower the viability of the seeds.

Selling screenings directly to a consumer requires either a consistent product or an analysis of each shipment. The high variability of screenings is obvious by a comparison of the results reported in Table 7 with those reported in Tables 12 and 21 (same data). These results are very different although the analyses were conducted on samples from the same treatments. This variability

makes it difficult to establish the feed value of screenings. The IVOMD results reported in Tables 12 and 21 are much more representative of the rations since they were made up of grab samples collected each day during the digestibility trials.

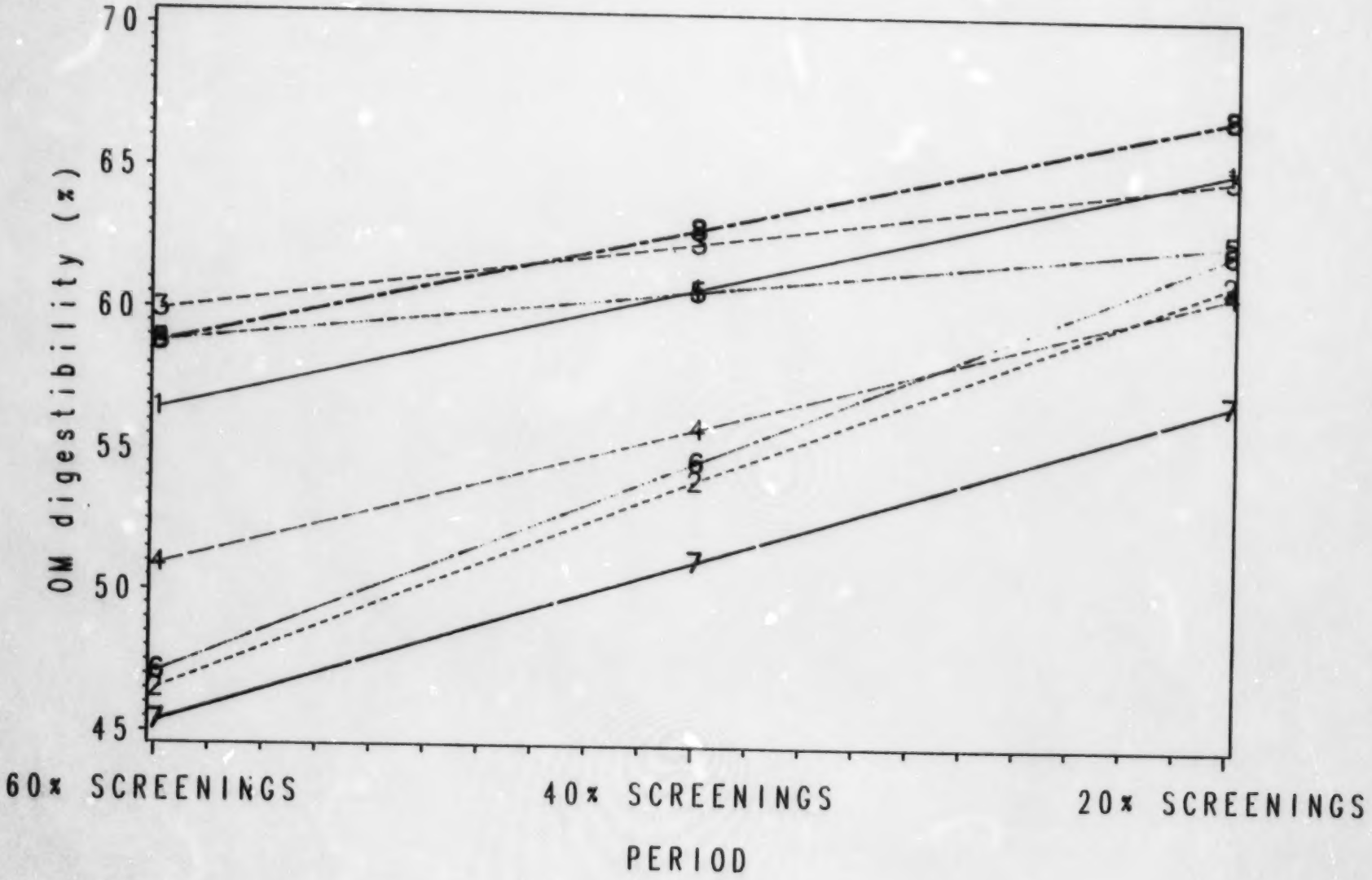

FIG. 1. Organic matter digestibility over the three levels of screenings for sheep using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

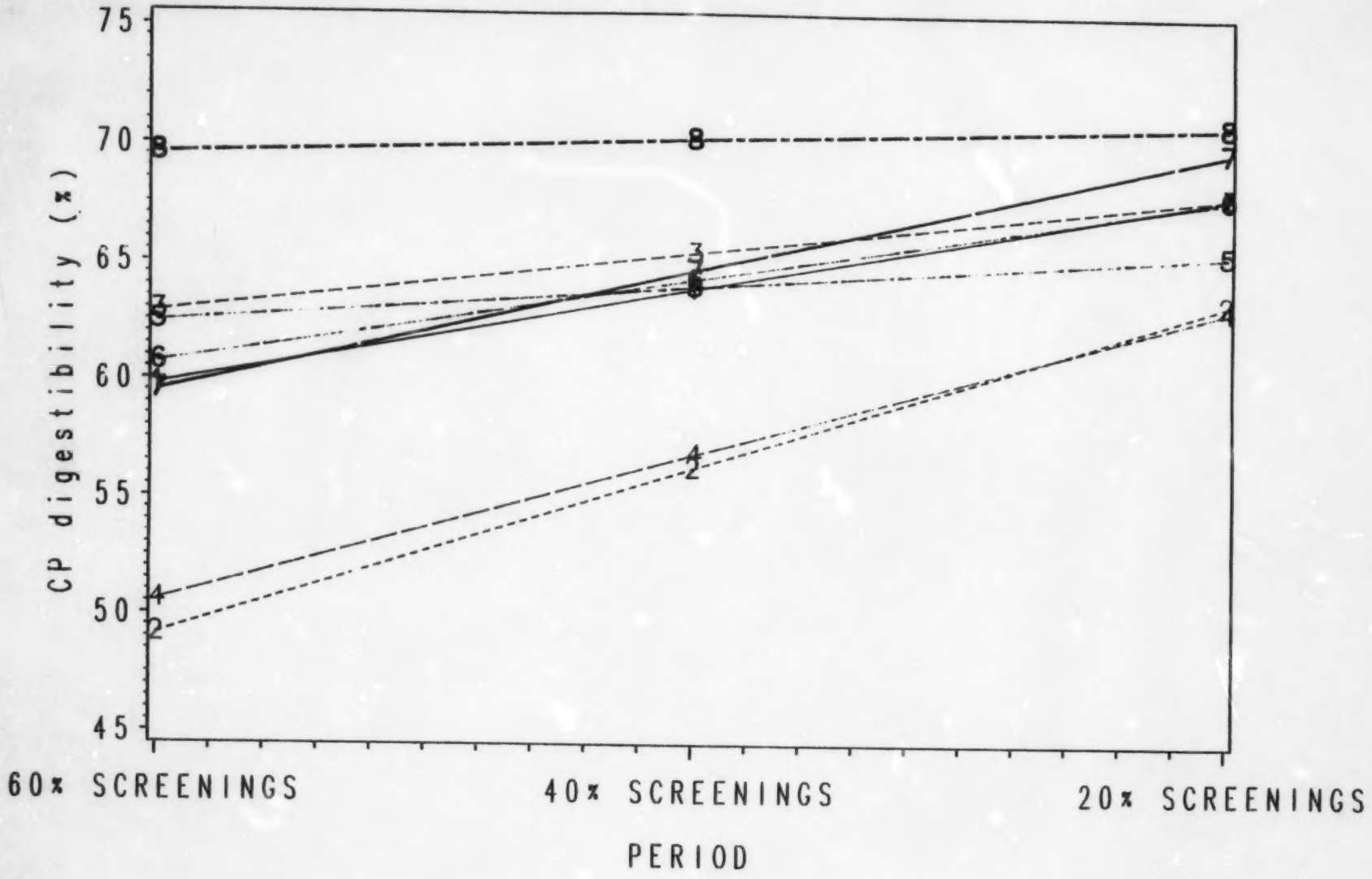

FIG. 2. Crude Protein digestibility over the three levels of screenings for sheep using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

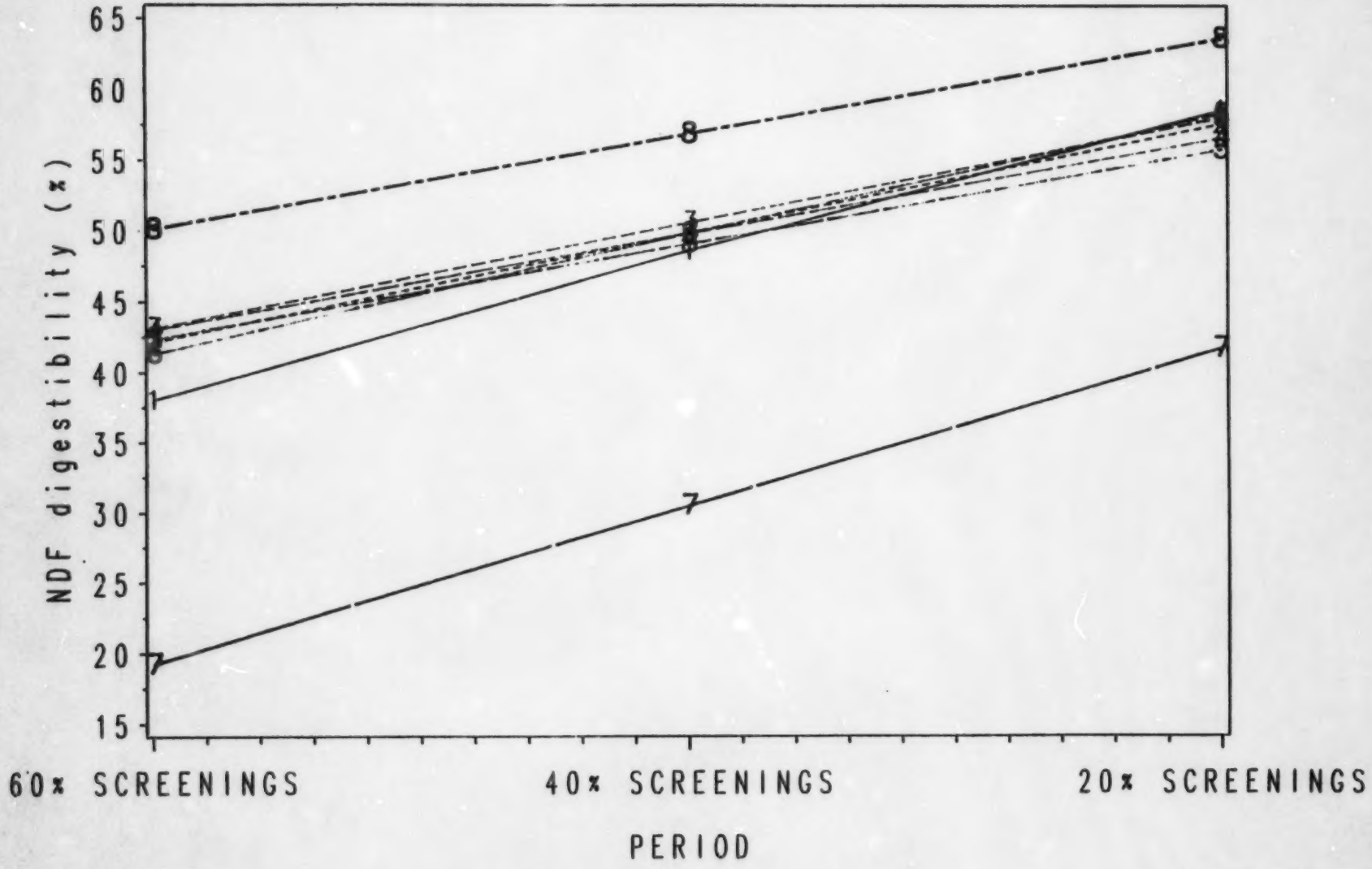

FIG. 4. Neutral detergent fibre digestibility over the three levels of screenings for sheep using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

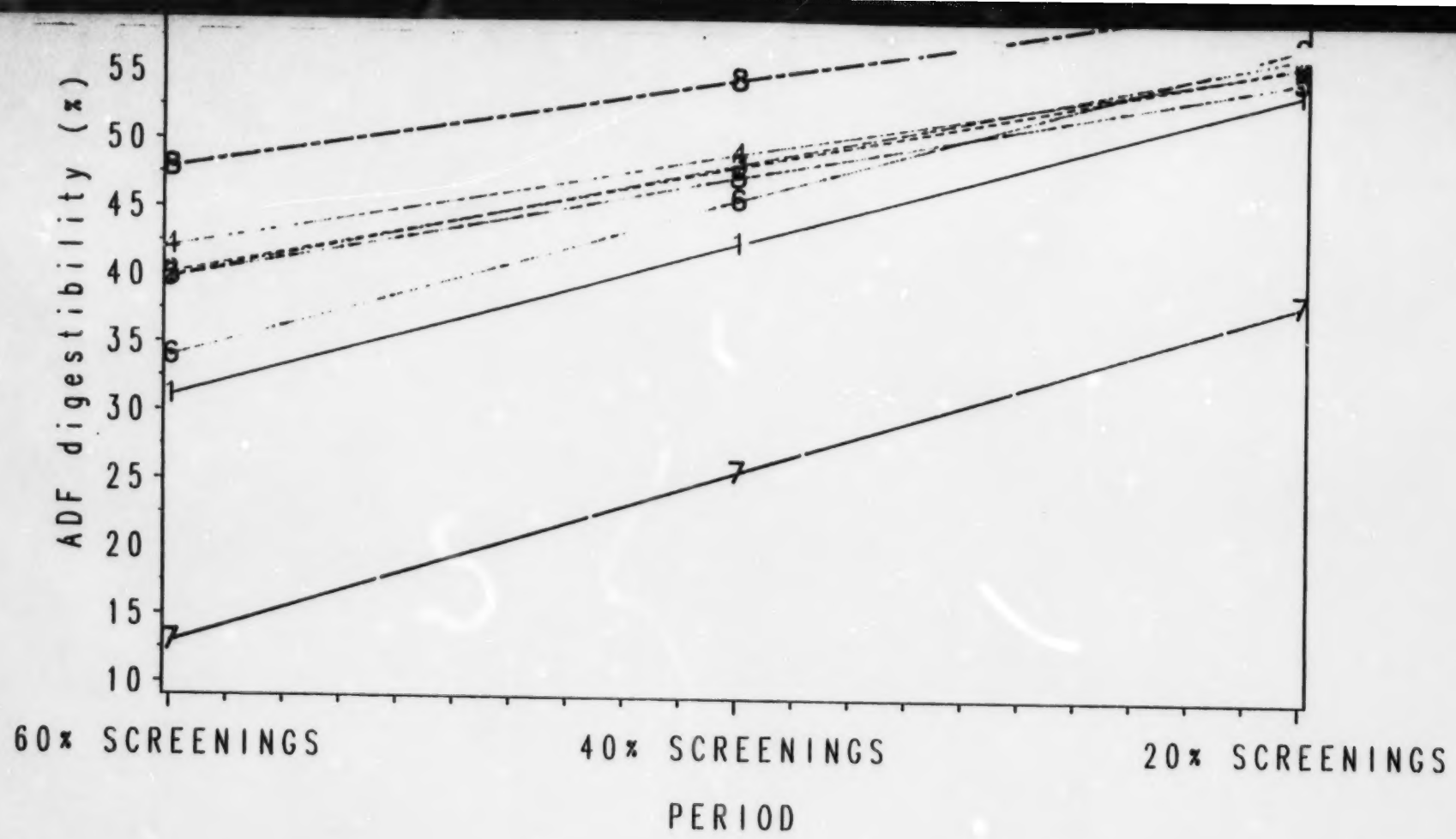

FIG. 5. Acid detergent fibre digestibility over the three levels of screenings for sheep using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

FIG. 6. Energy digestibility over the three levels of screenings for sheep using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

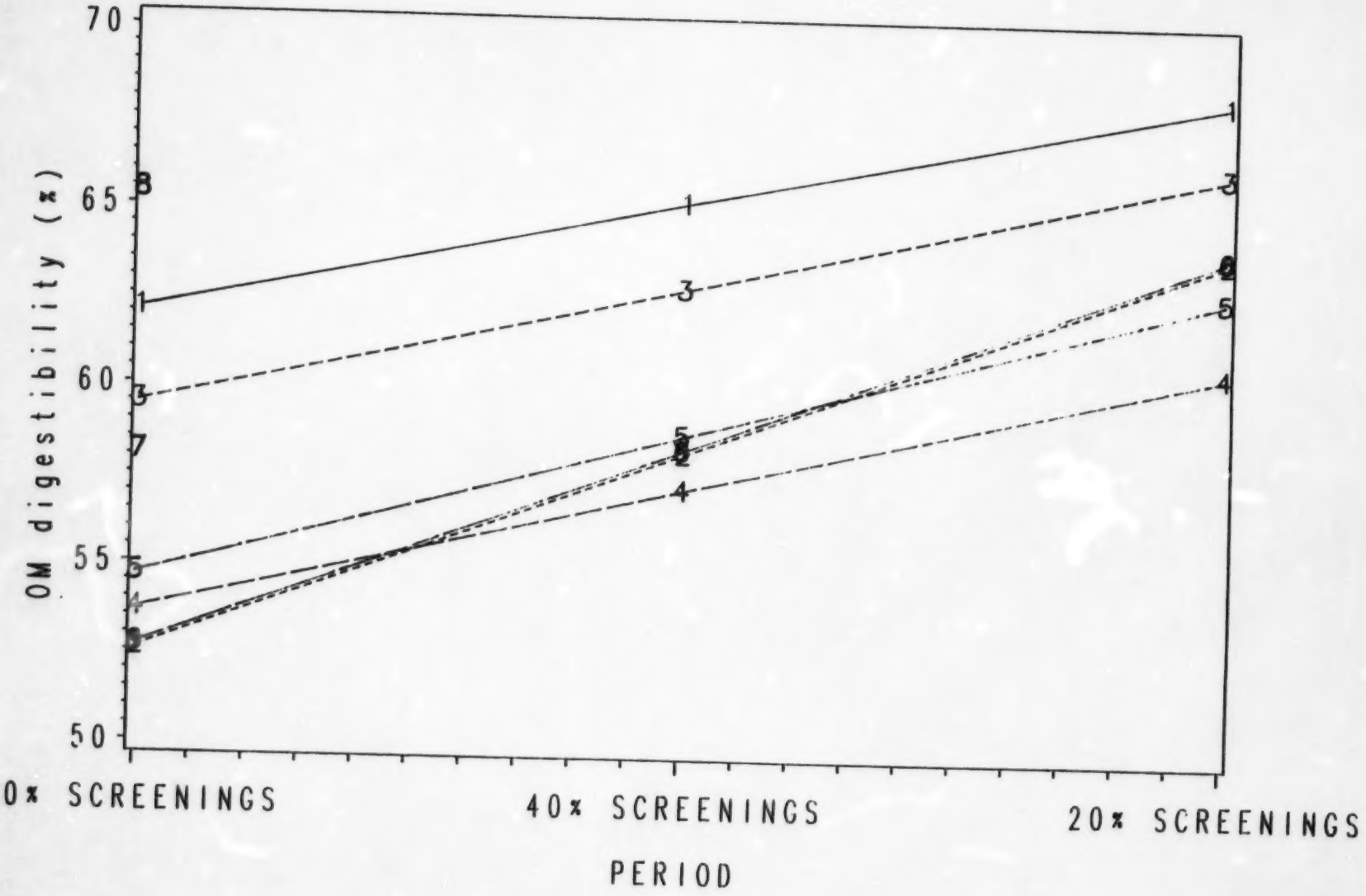

FIG. 7. Organic matter digestibility over the three levels of screenings for steers using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

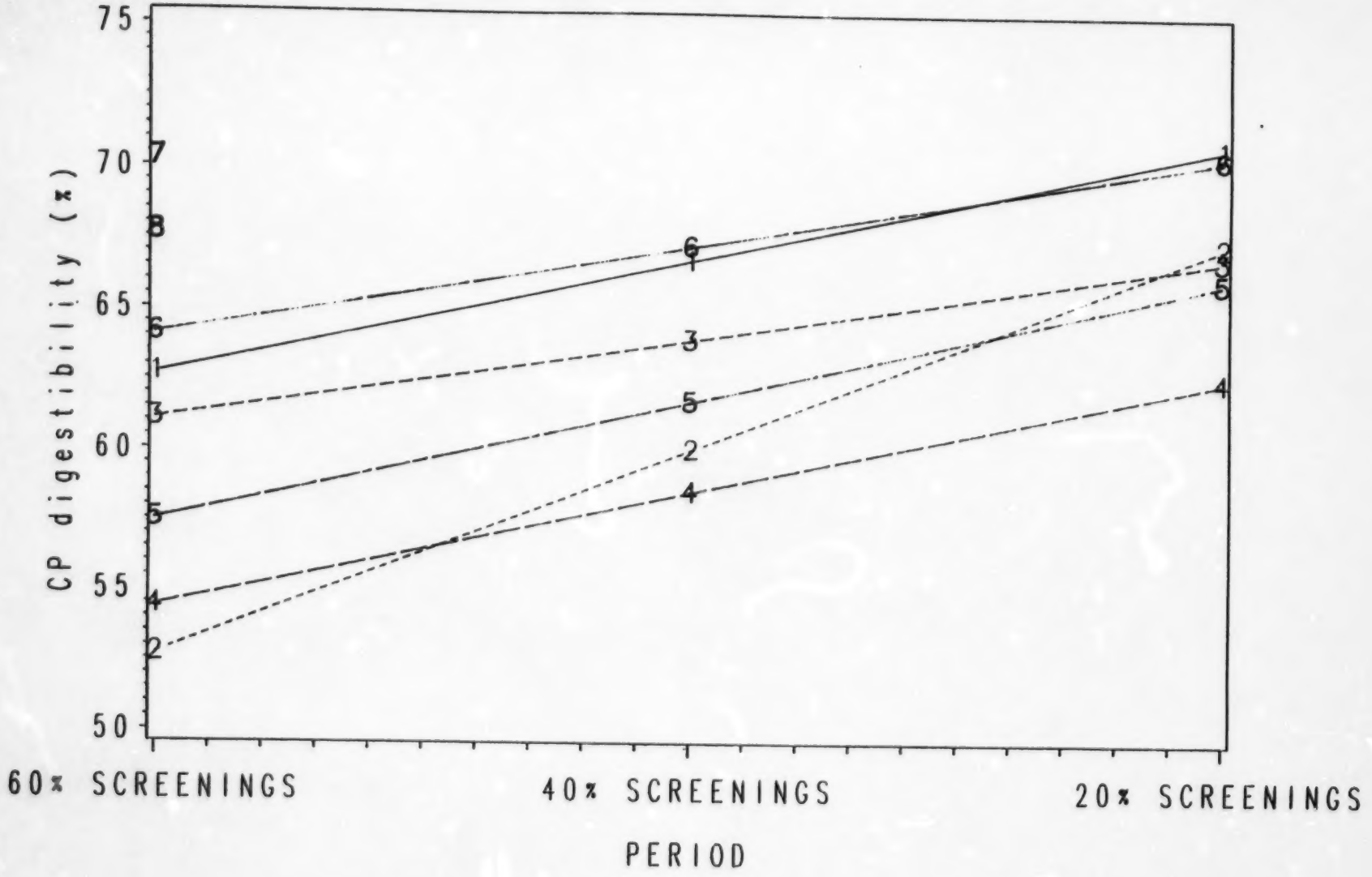

FIG. 8. Crude protein digestibility over the three levels of screenings for steers using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

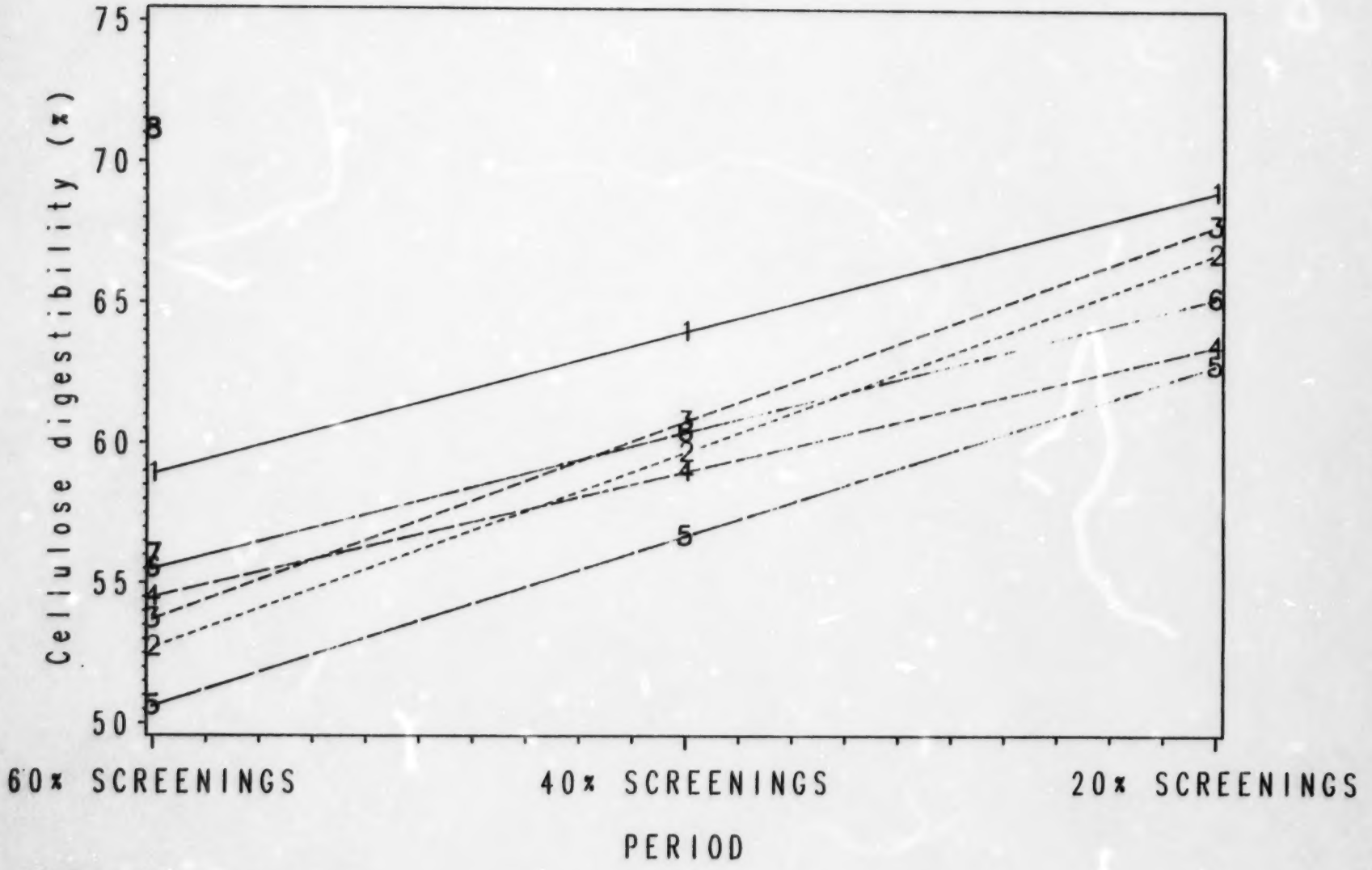

FIG. 9. Cellulose digestibility over the three levels of screenings for steers using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

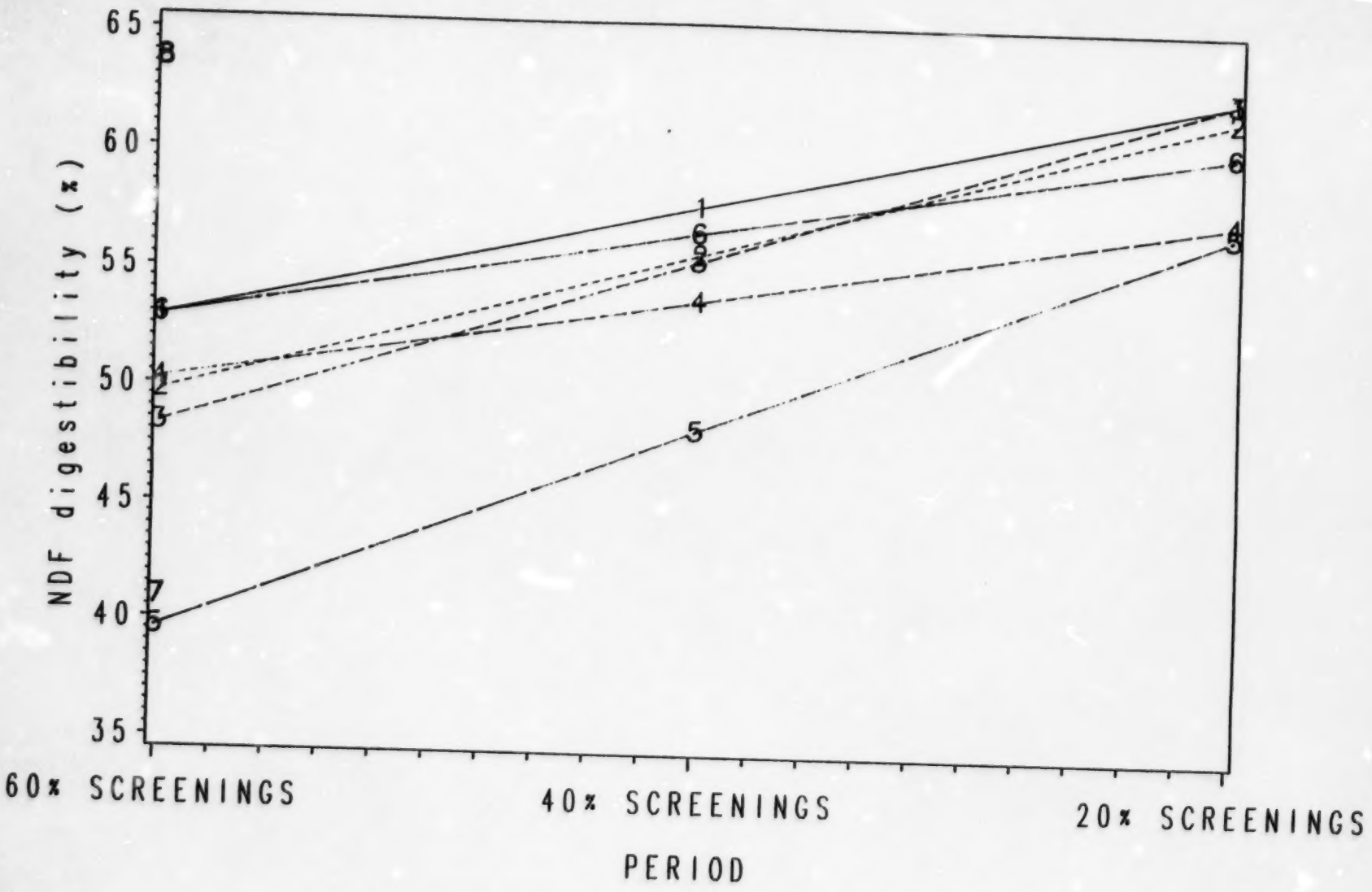

FIG. 10. Neutral detergent fibre digestibility over the three levels of screenings for steers using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

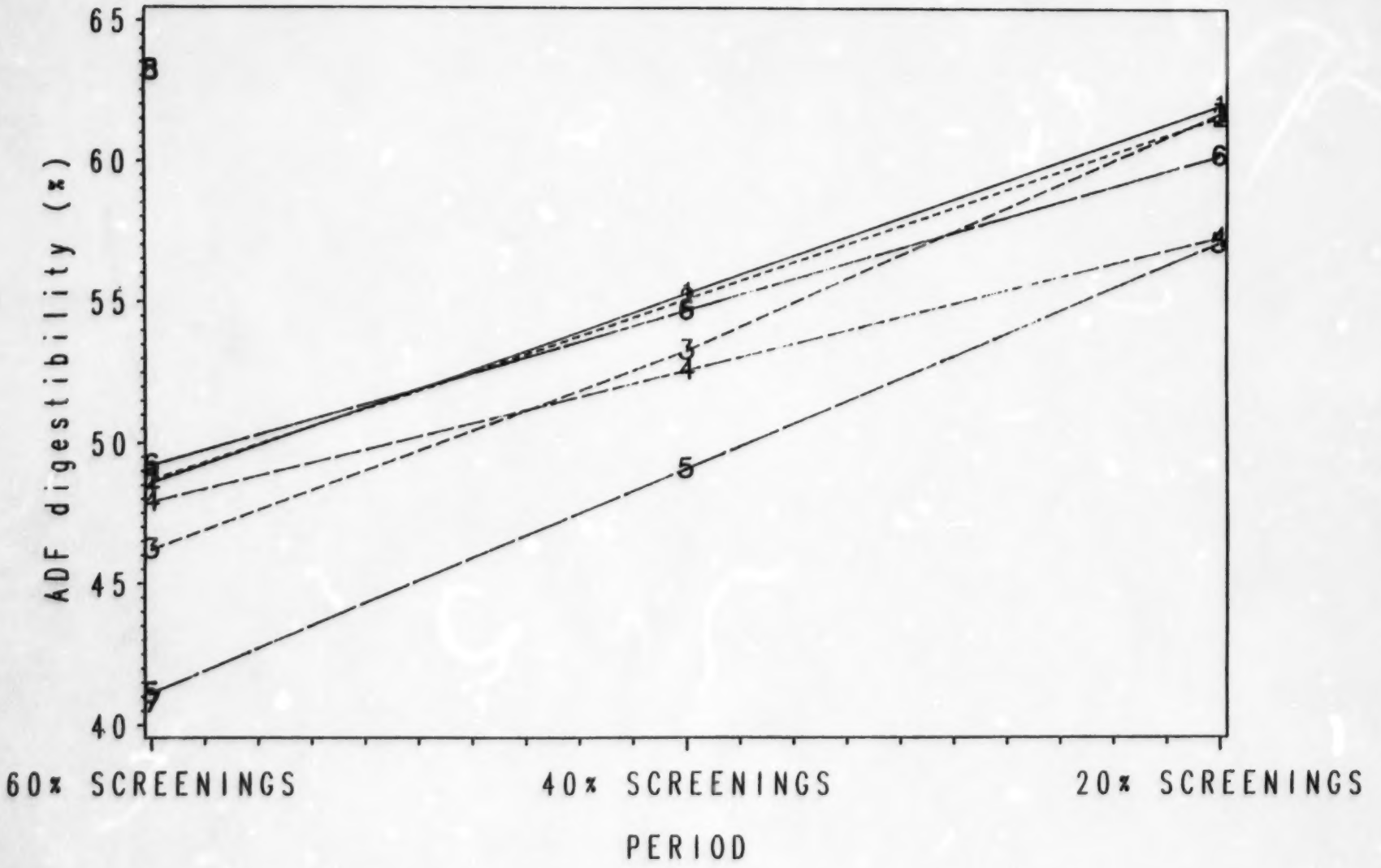

FIG. 11. Acid detergent fibre digestibility over the three levels of screenings for steers using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

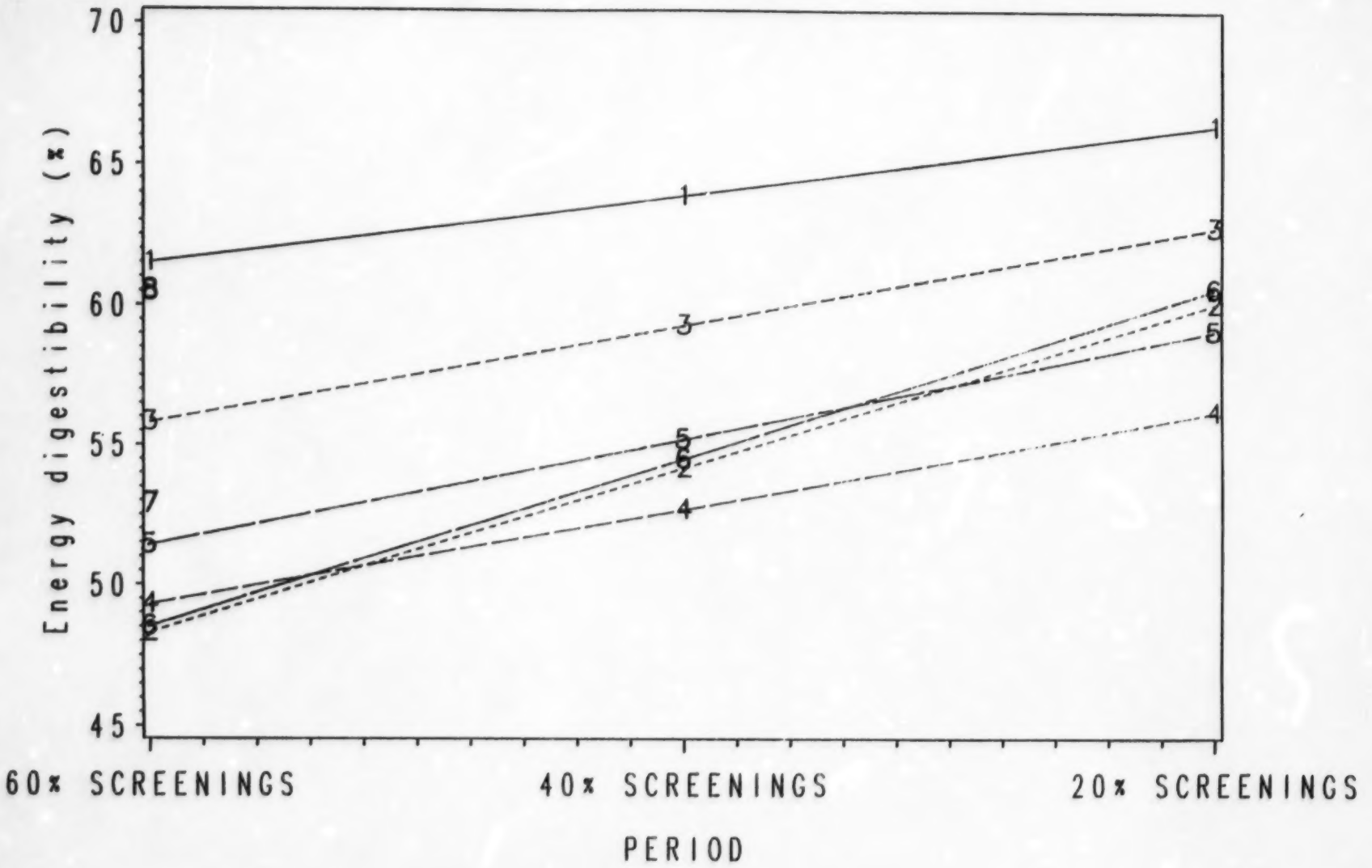

FIG. 12. Energy digestibility over the three levels of screenings for steers using linear regression.

PELLETED PLAIN=1 LOOSE PLAIN=2 PELLETED AMMONIATED=3 LOOSE AMMONIATED=4 PELLETED UREA=5 LOOSE UREA=6 PELLETED HAY=7 LOOSE HAY=8

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